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The determinants of remanufacturing practices in developing countries: Evidence from Thai industries

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ABSTRACT

Remanufacturing represents a significant End-of-Life (EoL) process for gaining environmental and economic advantages by extending product longevity, whilst reducing raw material consumption. Due to paucity of relevant empirical studies, this study aims to bridge the gap in remanufacturing knowledge by investigating the significant factors influencing firms' decisions to conduct remanufacturing in three Thai industries, namely automotive parts, photocopiers and agricultural machinery. This research combined qualitative and quantitative approaches involving the use of semi-structured interviews and questionnaires. Our results show that across all three industries, the most powerful determinant driving the decision making of firms constitute factors within the area of business feasibility, followed by elements in a firm's strategic factors and policy factors. Environmental regulations comprise the least important variable. Among the subordinate factors, financial aspects are ranked as the most crucial factor for conducting remanufacturing and acquiring cores matters for remanufacturing firms to increase their profit margins. All industries perceive product maturity, especially in terms of product lifespan, technological change and complexity, as the second most crucial factor in remanufacturing. As the industries under consideration are labor-intensive, skilled workers are needed and this is ranked as the third most influential factor to expedite remanufacturing. The firm's characteristics and the structure of particular industries are important in identifying the impact of influencing factors. A comprehensive development of policies and strategies and robust governmental support are needed to develop remanufacturing in Thailand.

1. Introduction

With growing concerns regarding environmental protection, many businesses have been encouraged to address environmental issues and face many challenges in doing this (Jiang et al., 2011). Remanufacturing represents a significant End-of-Life (EoL) process, which could potentially generate both environmental and business benefits. It extends product longevity while reducing raw material consumption, energy usage and environmental impact (Subramoniam et al., 2013). Hence, remanufacturing is considered a key strategy for promoting sustainable development (Matsumoto and Ijomah, 2013).

By definition remanufacturing is “the process of returning a used product to at least OEM (Original Equipment Manufacturer) original performance specification from the customers' perspective and giving the resultant product a warranty that is at least equal to that of a newly manufactured equivalent” (Ijomah, 2002). In reducing the utilization of raw materials, remanufacturing represents a great opportunity to construct a win-win situation for all relevant players, i.e. customers, businesses, the environment and society at large (Sharma et al., 2014). Remanufacturing also offers producers a method for avoiding waste limitation penalties by reintroducing waste matter into the manufacturing cycle (Ijomah et al., 2004).

In recent times remanufacturing has been concentrated in developed countries. In the U.S. a contemporary survey found over 6000 firms engaged in remanufacturing, involving approximately

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113 remanufactured goods (Lund and Hauser, 2010). Surveys of the U.S. and European manufacturing sector have indicated that remanufacturing contributes both high economic value and additional advantages to the economies involved (Subramoniam et al., 2010) and, therefore, deserves considerable attention from researchers (Kerr and Ryan, 2001).

Within developing countries remanufacturing practices have also recently become more important. Increased involvement with multinational enterprises, liberalization in investment and trade policies, as well as overconsumption of natural resources have all helped to encourage remanufacturing in these countries. China has pointed to remanufacturing as representing a key future manufacturing initiative within their National Long and Medium Term Program of Science and Technology Development Planning (Xiang and Ming, 2011); while in India GE Healthcare and Caterpillar have both realized remanufacturing advantages through either expanding their related activities or having plans to do so in the future (Rathore et al., 2011).

Although the remanufacturing approach is gaining popularity in developing countries, remanufacturing research remains in its infancy; with most research projects being conducted in China, India or Brazil. Yet it is important to understand the factors which have a bearing on the uptake of remanufacturing in developing countries because of the increasing industrialization of such countries and the threat of undesirable environmental repercussions if sustainable manufacturing approaches are not widely adopted in these nations. Lund (1984) has highlighted the importance of remanufacturing to developing countries. In response to the sparse number of empirical studies conducted in a developing country context, our research objective is to investigate the significant factors influencing a firm's decision to conduct remanufacturing focusing on three industries in Thailand, namely automotive parts, photocopiers and agricultural machinery, as case studies. These three types of product were chosen because they constitute the top three industries in Thailand which are suitable for remanufacturing (Kohpaiboon et al., 2011). The domestic markets for these products are considerable[1] and different degrees of remanufacturing have occurred within the three industries over a long period of time.

Thailand has the potential to become the remanufacturing hub of the Association of South East Asian Nations (ASEAN) countries because it has been thoroughly integrated into the global manufacturing network of leading multinational companies. Its workforce, therefore, has accumulated the manufacturing knowledge necessary for undertaking remanufacturing (Kohpaiboon et al., 2011). With the opening of Myanmar and the establishment of the ASEAN Economic Community (AEC), Thailand has the capacity to export remanufactured products to other ASEAN countries, especially CLMV, i.e. Cambodia, Laos, Myanmar and Vietnam (Kohpaiboon et al., 2012).

The rest of the paper is organized as follows. The second section presents a literature review with emphasis on the key factors influencing firms' decisions to conduct remanufacturing. The next outlines the methods and materials. The findings and a discussion make up section four, while the conclusions and contributions comprise the final section.

2. Literature review

The factors affecting the decision of a firm to conduct remanufacturing can be grouped into three main areas, namely business feasibility, firm's strategic factors and policy factors. There are also thirteen subordinate factors based on the prior literature (Fig. 1).

2.1. Business feasibility

There are four strategic factors impacting on remanufacturing profitability. First, technical aspects comprise product design and the product's capacity to be disassembled and re-assembled. When making products more remanufacturing-friendly, product design must take into account remanufacturability (Subramoniam et al., 2010) and product life cycle costs (Ijomah, 2009). The basic design requirements for a product to be suitable for remanufacturing are that it may be easily disassembled, cleaned, replaced and re-assembled (Zhang et al., 2011).

The second aspect of product maturity is related to both the speed of technological change and physical lifespan of products (Matsumoto, 2010). If a new product is subject to rapid technological change, component replacement is recommended, rather than remanufacturing. Likewise, if the lifespan of a product is prohibitively short, it is unsuitable for remanufacturing.

Since remanufacturing is labor intensive, the third influencing factor concerns the availability of skilled workers. As argued by Lundmark et al. (2009), the remanufacturing process tends to be quite complex and must be handled by skilled workers. Workers should be fully cognizant of a product's specifications in order to be able to both disassemble it and identify any parts to be replaced in order to replicate its original performance. The key importance of remanufacturing is that in comparison to conventional manufacturing, it requires proportionally much less skilled labor (Lund, 1984).

The final factor comprises the financial aspects that play a major role in conducting remanufacturing. Both the costs involved in establishing remanufacturing operations and the demand for remanufactured products represent two drivers impacting business profitability. The majority of costs incurred in remanufacturing arise from the additional resources required to return the product to its original performance capabilities. Such costs include expenses connected to direct production, quality assurance, and establishing the reverse logistics network necessary to acquire cores.[2] Many researchers emphasize the role of effective reverse logistic networks since they are considered the backbone of remanufacturing operations (Matsumoto, 2010). Sufficient demand for remanufactured goods is needed to sustain businesses. Seitz (2007) argued that the profitability of remanufacturing depends mainly on the customer demand for remanufactured goods. However, customers may have a negative perception of remanufactured products because they believe they may be of inferior quality compared to new goods (Abdulrahman et al., 2015).

2.2. Firm's strategic factors

Five firm-level strategic factors represent additional key variables determining the success of remanufacturing businesses. Undoubtedly, the global growth in environmental concerns and the

[1] Markets of automotive parts depend mainly on automotive industries. In 2013, Thailand was ranked as the 9th automobile producers in the world (OICA, 2014) and 1st largest in ASEAN and a major regional production base for automotive parts (TAI, 2012). Leading automobile multinational firms are located in Thailand, for example Toyota, Honda, Nissan, General Motors, and BMW. Domestic and export sales of automotive industry totally accounts for 10% of Thai gross domestic product (GDP). The market values estimate of used photocopier in Thailand was approximately US$ 60 million or account for 50% of new products. Importantly, leading multinational photocopier firm, Fuji-Xerox, has also established remanufacturing operation in Thailand. For agricultural machinery, its production values over US$ 300 million has increased over three times within over two decades (Kohpaiboon et al., 2011).

[2] Core is a used product that is a main component of a particular remanufacturing process, for example a used automotive part or used photocopier.